

Review

Prevention of diabetic foot ulcers: Holy grail of foot clinics

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Abstract

Diabetic foot ulcer is a common and debilitating complication of diabetes. Often this is preventable by regular screening and addressing risk factors such as regular podiatry, good foot wear and early consultation with health care professionals. General measures such as good glycaemic control, prevention of cardiovascular risk factors and prevention of deformity should be aimed during the early stages of the disease. Diabetic subjects should be encouraged to actively participate in their foot care. Prevention of foot ulcers will reduce the rate of amputation, which is common in diabetic subjects.

Key words: Diabetic foot ulcer, prevention, chronic complication.

Introduction

Diabetic foot ulcer (DFU) is one of the common but often neglected complications of diabetes (Figure 1). There is no doubt that people with DFU have considerable mortality and morbidity. The risk of death for those with foot ulcers is 12.1 per 100 person-years of follow-up compared with 5.1 in those without foot ulcers.¹ Similarly the risk for amputation in patients with diabetes is 15 times greater than for the non-diabetic population and the majority of amputations are preceded by DFU. In addition to increased morbidity and mortality, subjects with DFU have a poorer quality of life in comparison to those without ulcers.² The annual incidence of DFU is 2.5% and it is estimated that 15% of all diabetics are affected by diabetic foot ulcers during their lifetime causing a considerable financial burden on health care providers. In the UK alone it has been estimated that 1.25 million hospital bed-days per year at a cost of £220 million are required to treat diabetic foot problems.³ This figure does not include the whole cost, as there are almost seven times as many patients in the community as in the hospital.⁴ Similarly, in the USA, 15% of total admissions for people with diabetes during a two year period were related to foot problems which accounted for 23% of the total hospital days. Direct hospital costs for the treatment of diabetic foot infections exceed \$200 million per year and that for amputation related to diabetes exceed \$350 million annually.⁵

Despite this, DFU is often neglected by the mainstream medical specialities. One of the main reasons for this is the absence of coherent management policy of this disorder as various specialists such as podiatrists, vascular surgeons, orthopaedic surgeons, diabetologists, district nurses etc are involved in the management of DFU. More recently there has been increasing recognition of the problems caused by this condition and multidisciplinary foot clinics have been introduced in various parts of the world. Multidisciplinary care of foot ulcers can reduce the rate of amputation by as much as 50%.^{6,7} With increasing recognition of the

importance of this condition, the attention has now been focused on the prevention of this complication. In the UK, the National Service Framework of Diabetes⁸ has reiterated the importance of regular surveillance for the long-term complications of diabetes including that of diabetic foot problems and the key interventions planned are given in Table 1.

DFU is a preventable condition if high risk individuals are identified by appropriate screening programmes and are given appropriate foot care education. Similarly, if various chronic complications of diabetes such as neuropathy, peripheral vascular disease and foot deformities are prevented, it may be possible to prevent the development of DFU and its consequences. There have been exciting developments in this field and various new studies and observations are detailed below.

Prevention and treatment of neuropathy

Diabetic neuropathy is one of the main risk factors for the development of DFU as trauma to the insensate foot is usually the initiating cause of ulceration. In addition patients may not be aware of DFU at early stages, as they do not feel the pain caused by inflammation. Furthermore, this ulceration does not heal easily due to absence of the protective pain sensation.⁹ Neuropathy can affect up to 60% of all diabetic subjects and its prevention has not been successful.¹⁰ Good glycaemic control can reduce the risk of development of neuropathy but this is not easily achievable in the general diabetic population. Once established, the neuropathy becomes irreversible; however, there has been some encouraging data in the treatment of mild neuropathy with protein kinase C beta inhibitors¹¹ and alpha lipoic acids.¹² It is still too early to comment whether these treatments will be effective as previous trials with aldose reductase inhibitors¹³ and nerve growth factors¹⁴ were disappointing despite initial success.

Prevention and treatment of deformity

Foot deformity is another important cause of DFU, as deformed foot causes abnormal pressure,¹⁵ which eventually breaches the integrity of skin causing ulceration. One of the causes for the development of deformity is the imbalance

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Table 1: Key intervention suggested in the UK National Service Framework of Diabetes relating to the detection and management of long-term complication of diabetes

Key Interventions

- Regular surveillance for diabetic retinopathy in adults with diabetes and early laser treatment of those identified as having sight-threatening retinopathy can reduce the incidence of new visual impairment and blindness in people with diabetes.
 - Treatment of people who have microalbuminuria with ACE inhibitors can reduce their rate of progression to diabetic nephropathy.
 - Tight blood pressure and blood glucose control in people with diabetic nephropathy can reduce the rate of deterioration in their renal function, as well as their risk of cardiovascular disease.
 - People with diabetes identified as being at increased risk of developing lower limb complications can reduce this risk by participating in a foot care programme that provides foot care education, podiatry and, where required, protective footwear.
 - In people with diabetes who develop foot ulceration, prompt intervention can minimise their risk of subsequent disability and amputation.
 - People with diabetes who have established cardiovascular disease can benefit from the secondary prevention measures already recommended for the general population in the National Service Framework for Coronary Heart Disease.
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Table 2: General foot care advice given to patients with high-risk feet in order to prevent DFU

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- Do not walk barefoot even indoors
 - Keep your feet clean and moisturised (Like your face)
 - Look at your feet daily (or get some one to do it). Contact your doctor or podiatrist if there is a problem.
 - Wear well fitting shoes. There should be enough room to move your toes freely.
 - Always wear special shoes if you have been supplied with them.
 - Never treat your own corn or callus. See a registered podiatrist.
 - Do not use a hot water bottle. Wear woollen socks in bed if needed.
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between flexor and extensor muscles of the foot due to coexisting neuropathy.¹⁶ In diabetes, deformity due to Charcot neuroarthropathy is increasingly recognized.¹⁷ It is very important to prevent deformity in diabetic subjects by the use of sensible footwear. Similarly acute Charcot neuroarthropathy should be aggressively treated to maintain the normal architecture of the foot.¹⁷ There has been no controlled trial on surgical correction of deformity in the prevention of ulcers but it is worth considering. Recently, surgery to lengthen the Achilles tendon has been shown to be useful in the prevention of ulceration of metatarsal heads.¹⁸ If there is recurrence of ulceration over a bony prominence or on an abnormal weight bearing part, surgical correction may be indicated.

Prevention and treatment of Peripheral Vascular Disease

Ischaemia is the main reason for major amputations due to DFU. Peripheral vascular disease is more common in

diabetic subjects and the distribution of atherosclerotic lesions may be diffuse and more distal.¹⁹ As in the general population, the risk of vascular disease in diabetic population can be reduced by stopping smoking, low fat diet and regular exercise. In recent years various drugs have been shown to improve survival in cardiovascular disease but their role in the prevention of diabetic foot ulcers or diabetic peripheral vascular disease has not been analysed as a primary end point. Despite this, an argument for the use of aspirin, clopidogrel, statins, fibrates, ACE inhibitors and folic acid in diabetics can be made in the light of these evidences.²⁰⁻²⁴ On the other hand, agents such as naftidrofuryl and cilostazol, although helpful in controlling symptoms of intermittent claudication, have not found widespread use in diabetics with peripheral vascular disease as there is paucity of data on prevention of DFU or amputation.^{25,26} If a leg is critically ischaemic, vascular surgery is indicated to improve the blood supply²⁷



Figure 1: Plantar ulcer in a diabetic subject. The ulcer is present in abnormally high weight bearing area caused by deformity

but the role of prophylactic vascular reconstruction in mild to moderate disease for prevention of foot ulceration has not yet been established.

Glycaemic control

Normal glucose level is the first line of defence against chronic complications of diabetes. Good glycaemic control can prevent the development of neuropathy. Intensive blood glucose control reduced the development of neuropathy by 40% in type 2²⁸ and by about 60% in type 1 diabetes.²⁹ Raised HbA1c has also been associated with DFU, amputations and peripheral vascular disease. Therefore, it is very important to optimise glycaemic control to prevent DFU in the long run.

Regular podiatry

Regular podiatry care can prevent the development of DFU and prevent amputations.³⁰ Diabetic subjects should avoid treating their corn or callus by themselves and in high-risk feet even minor things like toe-nail clippings should be performed by a suitably qualified person. Presence of callus is a sign of abnormal shear forces in the foot and its removal is necessary to reduce high pressure in the foot. Regular removal of callus has been shown to prevent DFU.³¹ At each visit, the podiatrist should not only examine the foot but also reinforce foot care education.

Proper foot wear

Foot ulcers in diabetic patients are often caused by poorly fitting shoes. The diabetic patients should wear well fitting shoes to help prevent the development of pressure sores and ulcers. An easy way to choose a shoe is to buy a pair in which toes can be moved freely. Some people with neuropathy buy tight shoes as patients feel an appropriate size to be loose due to diminished sensation. Patients with

low or medium risk of ulceration should be advised to buy good quality shoes but those with high risk and in subjects who already developed DFU, custom-made shoes should be prescribed as these have been shown to prevent recurrences of DFU.³² Orthotists are of great help in designing appropriate footwear especially when there is severe foot deformity.³³ Patients should be advised to ensure that shoes are in a good state of repair and check for any foreign objects before they are worn.

Foot care education

Patient should be educated about foot care (Table 2). The patient or their carer should examine the feet at least once a day, if needed with the help of a mirror to look into the under surface. If they are educated to examine their feet, they can seek medical help before irreversible damage is done. A proper foot care education programme has been shown to reduce the risk of ulceration.^{34, 35} Patients usually become more receptive to medical advice after first ulceration, so an intensive education session with the physician or podiatrist or specialist nurse should be arranged to discuss foot care.

Detection of high-risk feet with screening

Various screening programmes are in use in various parts of the world, and in our area we have a podiatry led community diabetic foot screening programme. In Chorley & South Ribble, all newly diagnosed diabetic subjects are screened within 3 months of diagnosis. All diabetic subjects are offered a comprehensive foot-screening program (Figure 2). The patients are classified into high, medium and low risk categories by the screening podiatrist depending upon previous foot ulcers, neuropathy, ischaemia, deformity, smoking habit and vision. If they are

Copy 1: G.P. Practice Copy 2: Podiatry Copy 3: Diabetes register Chorley & South Ribble NHS Primary Care Trust
 Preston NHS Primary Care Group

DIABETES FOOT SCREENING

Sumname: Forename: DOB: NHS No.:
 Address: Tel:

Year of diagnosis: Control: Consultant / GP:

(Tick as appropriate)	RIGHT FOOT			LEFT FOOT		
FOOT PULSES	Not palpable	Palpable	Bounding	Not palpable	Palpable	Bounding
Dorsalis pedis						
Posterior tibialis						
FOOT TEMP	Cold	Warm	Hot	Cold	Warm	Hot
Forefoot						
Rearfoot						
SYMPTOMS	Yes	No		Yes	No	
Intermittent claudication						
Rest pain						
Painful neuropathy						

FOOT SENSATION (Key: ● = sensation absent ○ = sensation present)

MONOFILAMENT (10g)

Right Left

Dorsal sites

Plantar sites

SHARP/BLUNT

Right Left

FOOT SENSATION INTACT

RIGHT

LEFT

FOOT SENSATION PARTIAL LOSS
(1 or 2 absent sites)

RIGHT

LEFT

FOOT SENSATION ABSENT
(3 or more absent sites)

RIGHT

LEFT

Foot ulcer history	Foot deformity	Callus / corns / nail problems	Inappropriate footwear	Smoker	Poor eyesight	Lives alone
Y N	Y N	Y N	Y N	Y N	Y N	Y N

COMMENTS / ACTION:

RISK CATEGORY

HIGH RISK FOOT
(Podiatry annual assessment and care)

- Active foot ulceration
- History of foot ulceration / gangrene / amputation
- Ischaemia (i.e. absent foot pulses, claudication / rest pain)
- Absent sensation (3 or more absent sites)
- Charcot foot

MEDIUM RISK FOOT
(Podiatry annual assessment and care)

- Partial loss of sensation / peripheral circulation
- Foot deformity with reduced sensation / circulation
- SYMPTOMS ("mild" claudication, painful neuropathy in isolation)
- "OTHER RISK FACTORS AND SIGNS" (smoking, poor eyesight etc)

LOW RISK FEET
(Practice annual assessment)

- Podiatry care if needed
- No impairment to sensation or peripheral circulation
- Refer back to Podiatry if change in risk category or SOS

Date: _____
 Clinician: _____
 Position: _____
 Location: _____

Patient consent: _____
 Advice leaflet given: Y / N

PDS10

Figure 2: Diabetic foot screening form used in Chorley & South Ribble area. The podiatrists examine the foot of patients on diagnosis of diabetes and thereafter all high and medium risk feet are screened annually by the podiatrists whereas low risk feet are screened by practice nurses and referred to podiatrists if their risk status changes.

high or medium risk, they are screened annually by the podiatrist, but patients with low risk feet are screened by their diabetes care provider and can be referred to podiatrist if their risk status changes.

General patient education

There has not been any study to specifically look into various life styles and the development of DFU. In view of available knowledge based on the general population the following changes can be advocated.

Smoking

Smoking possibly increases mortality in people with diabetes. Although there has not been any study to look into association of smoking and development of DFU, one can assume that diabetic subjects who smoke may have an increased risk of foot complications and are more likely to have peripheral vascular disease and hence, likely to end up with amputations. All patients with diabetes should be encouraged to stop smoking.

Diet

Diabetic diet is the main treatment of diabetes to improve glycaemic control. These subjects should be actively

encouraged to lose weight if they are obese. This will not only improve the diabetes control but will also reduce the pressure on the foot. Similarly a low fat diet is important to reduce cardiovascular disease.³⁶

Exercise

Exercise/activity is beneficial for people with diabetes. Those with peripheral vascular disease and/or neuropathy are encouraged to be as active as possible. Physiotherapy can correct the gait abnormality and possibly prevent the development of DFU.³⁷

Alcohol

Alcohol consumption has been associated with the development of diabetic neuropathy.³⁸ On the other hand, moderate consumption has been shown to improve diabetes control and mortality in general population including diabetic subjects.³⁹ Men should drink no more than 21 units and women no more than 14 units each week.

Conclusion

DFU is associated with considerable morbidity and mortality to diabetic patient and poses a significant financial burden. This condition can be prevented with

appropriate interventions. Therefore, it is very important to recognise the diabetic foot, which is at risk by a good screening programme. Once identified, every care should be taken to prevent ulceration by educating patients and prescribing proper footwear. Patient empowerment to look after their own feet and to seek early help can reduce DFU and its consequences.

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